EFFECT OF RESPIRATORY MUSCLE STRETCH TO IMPROVE EXERCISE CAPACITY IN POST CORONARY ARTERY BYPASS GRAFT PATIENTS -An Experimental Study

Dissertation submitted to The Tamil Nadu Dr. M.G.R. Medical University towards partial fulfilment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Cardio Pulmonary Diseases) Degree programme.**

KMCH COLLEGE OF PHYSIOTHERAPY

(A Unit of Kovai Medical Centre Research & Educational Trust)

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CERTIFICATE

This is to certify that the research work entitled "**EFFECT OF RESPIRATORY MUSCLE STRETCH TO IMPROVE EXERCISE CAPACITY IN POST CORONARY ARTERY BYPASS GRAFT PATIENTS-An Experimental Study",** was carried out by the candidate bearing the **Register No. 27091613,** KMCH College of Physiotherapy, towards partial fulfilment of the requirements of The Master of Physiotherapy (MPT) degree course under, The Tamilnadu Dr. M.G.R. Medical University, Chennai – 32.

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INTERNAL EXAMINER

EXTERNAL EXAMINER

Dissertation Evaluated on:

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ABSTRACT

Objective: To study the effects of respiratory muscle stretch to improve the exercise capacity in patients with post coronary artery bypass grafting. **Design:** pre and post test experimental study design. **Setting:** Department of Physical Medicine and Rehabilitation, KMCH, Coimbatore. **Participants:** 40 subjects with post coronary artery bypass grafting surgery and divided into two groups, group A and group B each consists of 20 patients. **Intervention:** Group A received respiratory muscle stretch along with conventional physiotherapy and group B received conventional physiotherapy alone. **Main outcome measures:** Inspiratory muscle strength and exercise capacity were measured by using threshold IMT device and six minute walk test[third and seventh post operative day]. Six minute walk test was performed on seventh day after coronary artery bypass grafting surgery. **Results:** Statistical analysis were done by using paired‘t’ test and independent‘t’ test. In paired‘t’ test there is a significant difference in maximal inspiratory muscle strength within the groups (group A and group B). By using independent‘t’ test showed, that there is a significant improvement in group A than the group B and there is a significant difference in six minute walk test between the groups.

Conclusion: From the results, it was concluded, that the respiratory muscle stretch along with conventional physiotherapy improved the exercise capacity and inspiratory muscle strength in post coronary bypass grafting surgery.

KEY WORDS

CAD- Coronary Artery Disease

CABG- Coronary Artery Bypass Grafting

IMT- Inspiratory Muscle Training

1. INTRODUCTION

Ischemic heart disease is defined as the acute or chronic form of cardiac disability arising from the critical imbalance between the myocardial supply and demand for oxygenated blood. Since, narrowing or obstruction of the coronary arterial system is the most common cause of myocardial ischemia; it is termed as coronary artery disease .[3]

Coronary heart disease seems to be the most common form of heart disease and the single most important cause of premature death all over the world.

1.1. BACKGROUND OF THE PROBLEM

The number of people who are diagnosed as having coronary artery disease is increasing all over the world. In CAD, atherosclerotic plaques obstruct the coronary arteries. When the blockage becomes severe, the blood flow to the heart is restricted resulting in angina pectoris.

The acute stage of CAD occurs when one of the plaques rupture, forming a thrombus which later occludes the whole artery. The area of the heart muscle supplied by that artery dies and this is known as myocardial infarction.

Risk factors which predispose to disease include:

- Age
- High blood pressure
- Diabetes mellitus
- Hypercholesterolemia
- Tobacco smoking
- Family history related to coronary artery disease.
- Physical inactivity
- Obesity

The most commonly performed surgery for relief of angina and to improve heart muscle function is CABG (Coronary artery bypass grafting).[11]

1.2. CABG- THE SURGERY

CABG is a surgical procedure in which one or more coronary arteries are bypassed by a healthy blood vessel graft to restore normal blood flow to the heart.

1.3. PRINCIPLE

- To bypass obstructions in coronary arteries by using venous or arterial conduits taken from upper or lower limbs and inner chest wall.

- It re-establishes vascular supply to the distal areas of coronary circulation, previously limited by atheroma.

1.4. INDICATIONS

- Severe blockage in the main artery.
- Obstruction in severe blood vessels.
- Anginal chest pain not improved by drug therapy.[10]

1.5. PROCEDURE

The common incision used for CABG is median sternotomy, which is considered as one of the gold standard incision for most surgical procedures. Here, the sternum is cut down from the middle with a special bone saw and the chest is opened, a procedure known as CRACKING the chest. No muscle fibres are cut but the sternal attachment of the pectoralis major can be impaired. [22]

The surgery can be performed with cardiopulmonary bypass or without cardiopulmonary bypass. Off pump procedure is commonly associated with decreased morbidity levels. But, as with any surgeries, post-operative morbidity exists and physiotherapist tries to reduce this, aiding in early return of patients to normal activities.

1.6. BACKGROUND OF THE STUDY

Coronary artery bypass grafting is a surgical procedure developed during the 1960s for the treatment of coronary artery disease. Despite advance in surgical techniques and improvement in pre-operative and post-operative cases, the heart surgeries are responsible for high rates of morbidity and mortality.

Patients undergoing coronary artery bypass surgery often develop pulmonary dysfunction such as atelectasis, restrictive ventilatory disorder and hypoxemia.[39]

The pain and post-operative fear associated with changes in lung mechanics resulting from the surgery affect the performance of periodic deep inspiration and effective cough, allowing the accumulation of secretion, alveolar collapse and changes in gas exchange.

Maintaining respiratory muscle function is vital importance after CABG, to prevent post operative pulmonary complications.

These muscles are important in the maintenance of respiratory mechanics, and under pathophysiological conditions, muscle force is altered, which is reflected as a reduction in the respiratory pressure.[29]

The muscle is prevented from reaching sufficient peak tension, when it loses its normal flexibility, length tension relationship, which leads to muscle weakness and retraction. Factors, such as incorrect postural alignment, immobilization of muscle, muscle weakness, pain and aging can lead to muscle shortening.[20]

Jenkins et al suggested that the weakness of respiratory muscle is another mechanism contributing to restrictive ventilatory disorder, hypoxemia and ineffective cough.[4]

The function of the respiratory muscle is affected directly by thoracic incision, pain, paresis and / or diaphragmatic dysfunction as well as anesthesia and positioning on surgical table, which favors cephalic displacement of the diaphragm with reduction of respiratory muscle stretch.[46]

Traditionally, prevention and treatment of pulmonary complication have included early mobilization and physical therapy intervention such as deep breathing, coughing and incentive spirometry.[38]

But few studies are conducted a more active methods such as facilitating recovery of the natural functions of respiratory muscle after CABG.

Therefore, the purpose of this study is to find the effect of respiratory muscle stretch in CABG patients.

2. REVIEW OF LITERATURE

2.1. CORONARY ARTERY BYPASS GRAFTING

- **Patricia A Downie** told that Coronary artery bypass grafting is performed on persons with coronary artery disease to relieve the symptoms of angina and in certain groups of patients to prolong life.[32]

- Coronary artery bypass surgery may be an option, in which a donor vessel is used to bypass the involved lesion and establish an alternate blood supply in patients with coronary artery disease was explained by **Susan B. O'Sullivan.**[43]

- **Joanne Watchie** described that coronary artery bypass surgery, uses autogenous saphenous vein or arterial grafts [usually the internal thoracic or mammary artery or radial artery] to bypass stenotic lesions of the coronary arteries is performed primarily via a median sternotomy.[19]

- **Scott Irwin** too has suggested that coronary artery bypass surgery is performed on persons with coronary artery disease to relieve ischemia and intractable symptoms of angina and also improve the long term survival.[40]

- **Julian M Aroesty et al**; Coronary artery bypass graft surgery is a procedure to bypass narrowed areas and restore blood flow to heart muscles. It effectively relieves chest pain for most patients and can prolong the life for those with certain pattern of coronary artery disease.

- **Kolessov et al,** Coronary artery bypass grafting is a surgical procedure perform to relieve angina and the risk of death from coronary artery disease.[22]

- **American Heart Association (2004**) Coronary artery bypass graft surgery is advised for selected group of patients with significant narrowing and blockages of the heart arteries.

2.2. POST-OPERATIVE MORBIDITY

- **Sema Savci et al** concluded from their study that inspiratory and expiratory muscle strength decreased after coronary artery bypass grafting surgery due to pain and discomfort perceived by the patient. [41]

- **Berrizbeitia LD** Coronary artery bypass grafting is commonly performed via the median sternotomy and it was concluded that sternotomy caused a decrease in post operative pulmonary functions. [5]

- **Catherine M.Anderson** Cardiac and upper abdominal surgical procedures are associated with a high incidence of post operative pulmonary complications. [1]

- **Fawzy et al** proved on pump coronary artery bypass grafting via median sternotomy allows access to all coronary vessels. It is easier to bypass the more accessible coronary arteries. [12]

- **Ricardo costa-val** the heart surgeries are responsible for high rates of morbidity and mortality. Patient undergoing CABG surgery often develops pulmonary dysfunction such as atelectasis, restrictive ventilator disorder and hypoxemia.[39]

- **Jenkins et al** proved that the respiratory muscle function is affected directly by thoracic incision, pain, paresis and/ or diaphragmatic dysfunction as well as anesthesia and positioning on surgical table, which favors cephalic development of the diaphragm with reduction of respiratory muscle strength.[4]

- **Paulo Euardo Gomes Ferreira,** had insisted that there is a significant post operative reduction in respiratory muscle performance due to pain , the effects of cardiac surgery.[35]

- **Silva LHF, Torrents A,** has told that the respiratory complications are the most common causes of morbidity and mortality after cardiac surgery.[42]

2.3. RESPIRATORY MUSCLE STRETCH

- **Minoguchi Hideko et al** concluded Respiratory muscle stretch may have clinically significant benefits which may be somewhat different from the benefits of Inspiratory muscle training in patients with coronary artery bypass grafting.[27]

- **Yamada Minehiyo** suggested that Respiratory muscle stretch should be performed in 3 sessions 4 times each daily.[47]

- **Yutaka Tsuzura et al** suggested that Respiratory muscle stretch may have a beneficial effect on the respiratory pattern.[48]

- **Nobuko Aida et al** instructed patients to perform Respiratory muscle stretch before and after exercise therapy 3 times a day [morning, noon and night] until discharge. It facilitates co-ordinated contraction of the thoracic and abdominal walls to improve the ventilatory and non-ventilatory function of respiratory muscles.[37]

- **Yoshino Katsuki et al** concluded the Respiratory muscle stretch improves patient participations in exercise therapy and increase exercise capacity by reducing Post Coronary artery bypass grafting Pain [PCP].[37]
- **Kancho N** has insisted Respiratory muscle stretch is effective physical conditioning to improve pulmonary function and decrease dyspnea at rest and exertion in chronic obstructive pulmonary disease patients.[21]

- **Nobuki Miyara et al** proved that Respiratory muscle stretch stretches chest wall respiratory muscle during contraction and is considered to be effective physical conditioning method.

- **Tetsuo Miyagawa and Fumio Kokubu et al** compared the effect of Respiratory muscle stretch with that of inspiratory muscle training [IMT] using the threshold device, suggested that Respiratory muscle stretch decreases chest wall stiffness. It may have clinically significant benefits of patient with chronic obstructive pulmonary disease.[44]

- **Marlene Aparecido Moreno et al** concluded Respiratory muscle stretching was efficient in promoting an increase in maximal respiratory pressure, thoracic expansion and abdominal mobility.

- **Nobuaki Miyahra et al** suggested Respiratory muscle stretch are designed to stretch inspiratory muscle during inspiration and expiratory muscle during expiration followed by exercise on a calibrated cycle ergometer under the supervision of a physical therapist.

- **Fuiiyasu Kakizaki et al,** in this study on 22 patients has shown that the respiratory muscle stretch gymnastics increase chest wall mobility, possibly by reducing chest wall elastance in patients with COPD.[14]

- **Onodesa A et al,** suggested that the respiratory muscle stretch gymnastics reduces dyspnea, increase functional capacity, decrease total lung capacity and residual volume on patients with chronic respiratory failure due to pulmonary emphysema.[31]

2.4. CONVENTIONAL PHYSIOTHERAPY

- **Julia Alencar Renault et al** compared the effects of deep breathing exercise and incentive spirometer in patients undergone coronary artery bypass grafting and concluded there was no observed significant differences in patients undergone deep breathing exercise and incentive spirometer after coronary artery bypass grafting.[39]
- **Tom J. Overnd et al** suggested inspiratory spirometer remains a widely used technique for the prophylaxis and treatment of respiratory complication in post-surgical patients, but presently the evidence does not support use of incentive spirometer for decreasing the incidence of post-operative complications following cardiac surgery.[1]

- **Elisabeth Westerdal et al** concluded that patients performing deep breathing exercise after coronary artery bypass grafting surgery had significantly smaller atelectactic area and better pulmonary function compared to control group.[10]

- **Patricia A. Downie** insisted that diaphragmatic breathing exercise should also involve concentration on full range movement of the diaphragm to prevent pleural adhesion formation post-operatively.[32]

- **Carolyn Kisner** insisted that diaphragmatic breathing exercise continued to be an integral part of most cardiopulmonary physical therapy programme but research on the effects of diaphragmatic breathing exercise continued .[6]
- **Elizabeth Dean** emphasized that patient education in most open heart surgery units may contribute to the generally low incidence of complications and mortality.[11]

- **Joanne Watchie** suggested that diaphragmatic breathing exercise are traditionally performed to improve ventilation, decreased work of breathing and reduce the incidence of post-operative pulmonary complications.[19]

- **Weiner, Magadle et al** has reported that there are only few reports on the role of respiratory muscle training in the prophylaxis of respiratory complications arising in cardiac post operative period.[45]

2.5. SIX MINUTE WALK TEST

- **Claudia florin et al** concluded that 6 minute walk test is well tolerated in adult and older patient shortly after uncomplicated cardiac surgery.[7]

- **American journal respiratory critical care medicine 2002:** They concluded six minute walk test is a useful measure of functional capacity targeted at people with atleast moderately severe impairment. The test has been widely used for preoperative and post operative evaluation.

- **De feo, Stefania et al** suggested that six minute walk test has been proposed both as a functional status indicator and as on outcome measure in various categories of patients (post myocardial infarction, post cardiac surgery).[8]

- **Gordon H. Gujatt, Sullivan et al concluded** that the six minute walk test is a useful measure of functional exercise capacity and a suitable measure of outcome for clinical trial in patients with heart problem.[15]

- **Paul. Enright and Duane L. Sherrill et al** in their study proved that six minute walk test can be performed by elderly, frail and severely limited patients who cannot be tested with cycle ergometer and treadmill test.[34]

- **Lynn V. Doering et** al concluded that the six minute walk test provides on objective measure of functional status and exercise tolerance, is often used to access these parameters in cardiac patients and is a useful indicator of changes in functional status after intervention.[24]

- **J.M. Anderson and D. M. Innocenti** proved that objective six minutes walk test can give an accurate assessment of the patient's conditions and his response to treatment.[2]

- **Gujah and Colleagues** in 1985 suggested the six minute walk test is on inexpensive and highly safe exercise tolerance test in cardiac patient.[16]

- **Joanne Watchie,** six minute walk test is the most extensively researched and established walk test and is better tolerated than the 12 minute walk test in patient with respiratory and cardiovascular disease.[19]

- **Du dziak, M; Rogowski.J,** Concluded that six minute walk test is better tolerated and better reflex activities modalities in group of patients referred for cardiac rehabilitation after CABG than other exercise test. [9]
- **Angela chang** suggested six minute walk test is a commonly used objective measure of functional exercise capacity in individual with moderately severe impairment.[3]

- **Paul. L. Enright** six minute walk test is a useful measure of functional capacity targeted at people with pulmonary and cardiac disease.[34]

2.6. MAXIMUM INSPIRATORY PRESSURE

- **Dudziak. M; Rogowski. J. J** concluded that inspiratory pressures developed by inspiratory muscle contraction are particularly valuable for assessing possible respiratory muscle weakness.[9]

- **Joanne Watchie** has used the maximal inspiratory pressure as a outcome measure which is useful in documenting the strength of respiratory muscle.[19]

- **Ricardo stein** concluded that the inspiratory muscle strength as a determinant of functional capacity early after coronary artery bypass grafting surgery.[38]

3. AIM AND OBJECTIVES

3.1. AIM

To find the effect of respiratory muscle stretch in improving exercise capacity in post coronary artery bypass grafting patients.

3.2. OBJECTIVES

- To analyze the effect of respiratory muscle stretch.
- To improve the exercise capacity.
- To improve the chest expansion.
- To improve the inspiratory muscle strength.

4. MATERIALS AND METHODOLOGY

4.1. STUDY DESIGN

Pre and Post test experimental study design.

4.2. STUDY SETTING

Cardio-Thoracic Surgical Unit and,

Kovai Medical Centre and Hospital,

Coimbatore.

4.3. STUDY POPULATION

40 post CABG patients.

Group A - 20 post-CABG patients.

Group B - 20 post-CABG patients.

4.4. SAMPLING TECHNIQUE

Purposive Sampling.

4.5. SAMPLE METHOD

Sampling method includes 2 groups with 20 patients each as:

Group A - Respiratory muscle stretch along with conventional therapy.

Group-B - Conventional physiotherapy (Deep breathing exercise, incentive Spirometry and coughing)

4.6. STUDY DURATION

Duration**:** 1 Week

Session: 3 sessions per day

4.7. CRITERIA FOR SELECTION

4.7.1. INCLUSION CRITERIA

- CABG with median sternotomy
- Both males and females
- Age group- 50 to 70 years
- Medically stable and co-operative patients

4.7.2. EXCLUSION CRITERIA

- Severe respiratory disease
- Post- operative mediastinal infection
- Osteoporosis
- Patients with systemic illness
- Patients with neurological complications
- Orthopedic disease with motor dysfunction
- Psychiatric disease

4.8. HYPOTHESIS

4.8.1. NULL HYPOTHESIS

H_{01}- There is no significant effect of respiratory muscle stretch along with conventional physiotherapy in improving exercise capacity and inspiratory muscle strength in patients after CABG.

H_{02}- There is no significant effect of conventional physiotherapy in improving exercise capacity and inspiratory muscle strength in patients after CABG.

H_{O3}-There is no significant difference between respiratory muscle stretch with conventional physiotherapy and conventional physiotherapy alone in patients after CABG.

4.8.2. ALTERNATE HYPOTHESIS

H_{A1}- There is significant effect of respiratory muscle stretch along with conventional physiotherapy in improving exercise capacity and inspiratory muscle strength in patients after CABG.

H_{A2}- There is significant effect of conventional physiotherapy in improving exercise capacity and inspiratory muscle strength in patients after CABG.

H_{A3}- There is significant difference between respiratory muscle stretch with conventional physiotherapy and conventional physiotherapy alone in patients after CABG.

4.9. MEASUREMENT TOOLS

1] Threshold Inspiratory Muscle Trainer [IMT] device

2] Six Minute Walk test

4.10. PROCEDURE

4.10.1. RESPIRATORY MUSCLE STRETCH

Respiratory muscle stretch is given in the following way-

Patient is instructed to perform respiratory muscle stretch before and after the exercise for 4 repetitions and 3 times a day.

CONTENTS OF RESPIRATORY MUSCLE STRECH

RMS 1- Whole body relaxation.

Either lying down or sitting in a chair, contract the muscles of the face, shoulder, hands and feet for several seconds and exhale deeply to relax all muscles of the body.

Fig 1 Whole body relaxation

RMS 2- Bending the neck forwards and to both sides.

Raise shoulders for 5 seconds, then exhale deeply to relax totally. While pursing the lips, exhale and bend neck to the right to stretch the strenocleidomastoid, then inhale while bringing the neck to the original position. Exhale deeply to relax totally.

Fig 2 Raising Shoulders for relaxation

Fig 3 Bending neck forward & to sides

RMS 3- Rotating the shoulder, including the pectoralis major and trapezius muscle.

Gradually rotate the shoulder and scapula forward a few times then exhale deeply to relax totally.

Fig 4 **Rotating the Shoulders, including Pectoralis major and Trapezius muscle**

RMS 4- Stretching the shoulder girdle and triceps brachii muscle.

Extend arm forward as far as possible and retain this position for 5 seconds.

Slowly raise the elbow vertically while inhaling to extend the anterior serratus muscle under the armpit. While exhale, return arm to original position and relax.

Fig 5 **Stretching Shoulder girdle and Triceps, Brachii muscle**

RMS 5- Stretching of the triceps brachii muscle and serratus anterior muscles.

While using one hand to protect the wound, place the other hand on opposite shoulder and while exhaling deeply, return arm to original position and relax totally.Repeat above procedures by changing the sides.

Fig 6 Stretching Triceps Brachii and Serratus Anterior muscles

4.10.2. DIAPHRAGMATIC BREATHING EXERCISE

Procedure:-

The techniques for teaching diaphragmatic breathing exercises are as follows:-

1. Position the patient in a relaxed and comfortable manner in which gravity assists the diaphragm such as semi fowlers position.

2. Explain the purpose and goals of the exercise and then explain and demonstrate the desired results.

3. Place one hand on the rectus abdominis just below the anterior costal margin. Ask the patient to breath in slowly and deeply through the nose.

4. Have the patient keep shoulders relaxed and upper chest quiet, while allowing the abdomen to rise. Then, ask the patient to slowly let the air out using controlled breathing.

5. Have the patient practice this, for three or four times and then take rest. Do not allow the patient to hyperventilate.

6. Have the patient place his own hand below the anterior costal margin and feel the movement. The patients hand should rise during inspiration and fall during expiration.

After the patient understand and is able to breath using diaphragmatic pattern, suggest that he or she breath in through the nose and out through mouth.

4.10.3. INCENTIVE SPIROMETRY

Incentive spirometry also is a form of low level resistance training that emphasizes sustained maximum inspiration. The patient inhales deeply through a spirometer that provides visual or auditory feedback.

Procedure

1. Place the patient in a comfortable position.

2. Have the patient take three or four slow, easy breaths and maximally exhale with the fourth breath.

3. Then have the patient place the spirometer in the mouth, maximally inhale through the spirometer and hold the inspiration for several seconds.

4. This sequence is repeated 5-10 times, several times per day.

4.10.4. COUGHING TECHNIQUE

An effective cough is necessary to eliminate respiratory obstruction and keep the lungs clear.

The following procedures are used when teaching an effective cough-

1. The patient is placed in a relaxed and comfortable position for deep breathing and coughing. Sitting or lean forward is usually the best position for coughing. The patients neck should be slightly flexed to make the coughing more comfortable.

2. Teach the patient controlled diaphragmatic breathing exercise, emphasize deep inspirations.

3. Demonstrate sharp, deep double cough.

4. Demonstrate proper muscle action for coughing. Have the patient make three huffs while placing hands on the abdomen with expiration to feel the contraction of the abdominals.

5. When the patient have put these actions tighter, instruct the patient to take a deep but relaxed inspiration, followed by sharp double cough.

4.11. OUTCOME MEASURES

- Maximum Inspiratory Pressure [PI_{max}] - measured on 3rd and 7th post-operative day.
- Six Minute Walk Test – Distance covered measured on 7th post-operative day.

4.12. STATISTICAL ANALYSIS

Pre-test and Post-test values of the study are collected and assessed for variation in improvement & their results are analyzed using Independent `t' test and Paired `t' test.

- INDEPENDENT `t' TEST (between groups)

$$t = \frac{\overline{X1} - \overline{X2}}{S} \sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where,

$$S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}}$$

- PAIRED `t' TEST (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where,

$$S = \sqrt{\frac{\sum d^2 - \left[\bar{d}\right]^2 \times n}{n-1}}$$

S=combined standard deviation

$d_1 \& d_2$ =difference between initial & final readings in group A & group B

respectively.

$n_1 \& n_2$=number of patients in group A & group B respectively.

$\overline{X_1} \& \overline{X_2}$ =Mean of group A & group B respectively.

Level of significance: 5%

5. DATA REPRESENTATION

5.1. TABULAR PRESENTATION

PAIRED‘t’ TEST:

Table I:- Maximum Inspiratory Pressure [Group A]

Mean values (cmH_2O)	**GROUP A**	
	Pre test	Post test
	17.5	23.3
Calculated ‘t’ value	12.78	
Table ‘t’ value	1.729	
p value and Level of significance	p < 0.05 and significant	

Table II:- Maximum Inspiratory Pressure [Group B]

Mean values (cmH_2O)	**GROUP B**	
	Pre test	Post test
	16.8	22.95
Calculated ‘t’ value	14.24	
Table ‘t’ value	1.729	
p value and Level of significance	p < 0.05 and significant	

INDEPENDENT 't' TEST:

Table III:- Pre-test of Maximum Inspiratory Pressure [between group A & B]

Mean values (cmH_2O)	**Pre test**	
	GROUP A	GROUP B
	17.5	16.8
Calculated 't' value	2.763	
Table 't' value	1.645	
p value and Level of significance	p< 0.05 and significant	

Table IV:-Post-test of Maximum Inspiratory Pressure [between group A & B]

Mean values (cmH_2O)	**Post test**	
	GROUP A	GROUP B
	267.35	234.4
Calculated 't' value	5.699	
Table 't' value	1.645	
p value and Level of significance	p< 0.05 and significant	

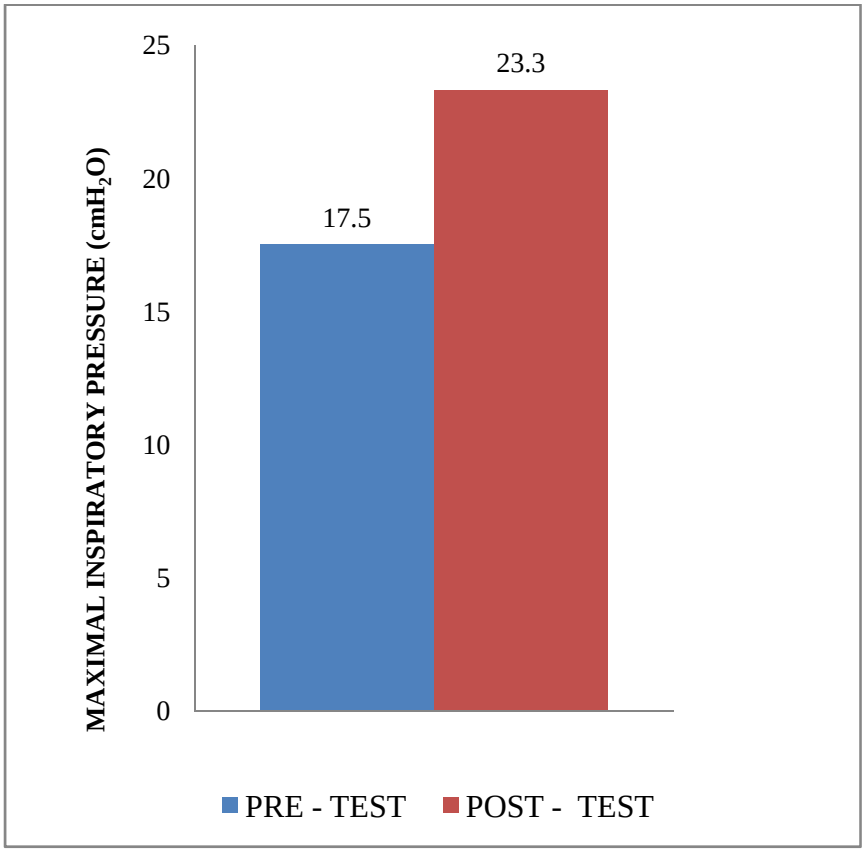
Table V:- Six Minute Walk Test

Mean values (meters)	**Post test**	
	Group A	Group B
	267.35	234.4
Calculated 't' value	5.699	
Table 't' value	1.645	
p value and Level of significance	$p < 0.05$ and significant	

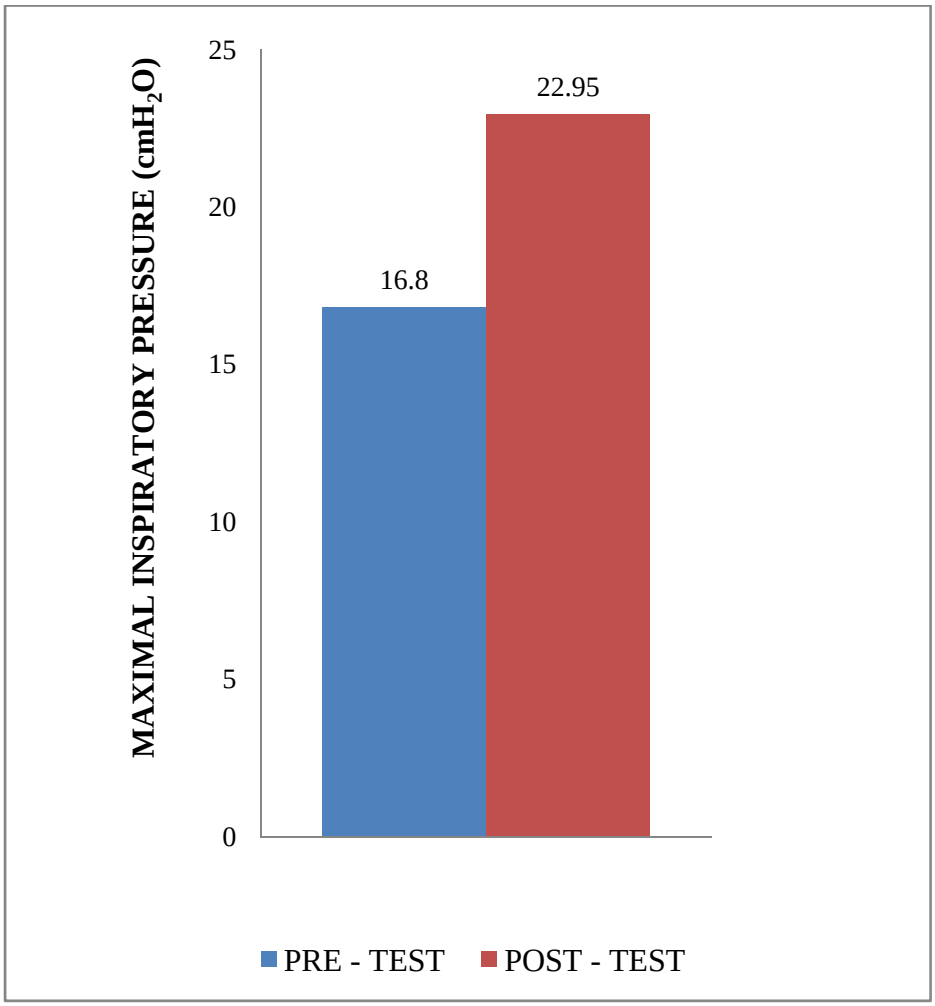
5.2. GRAPHICAL REPRESENTATION

↳ Maximum Inspiratory Pressure [PI_{max}]

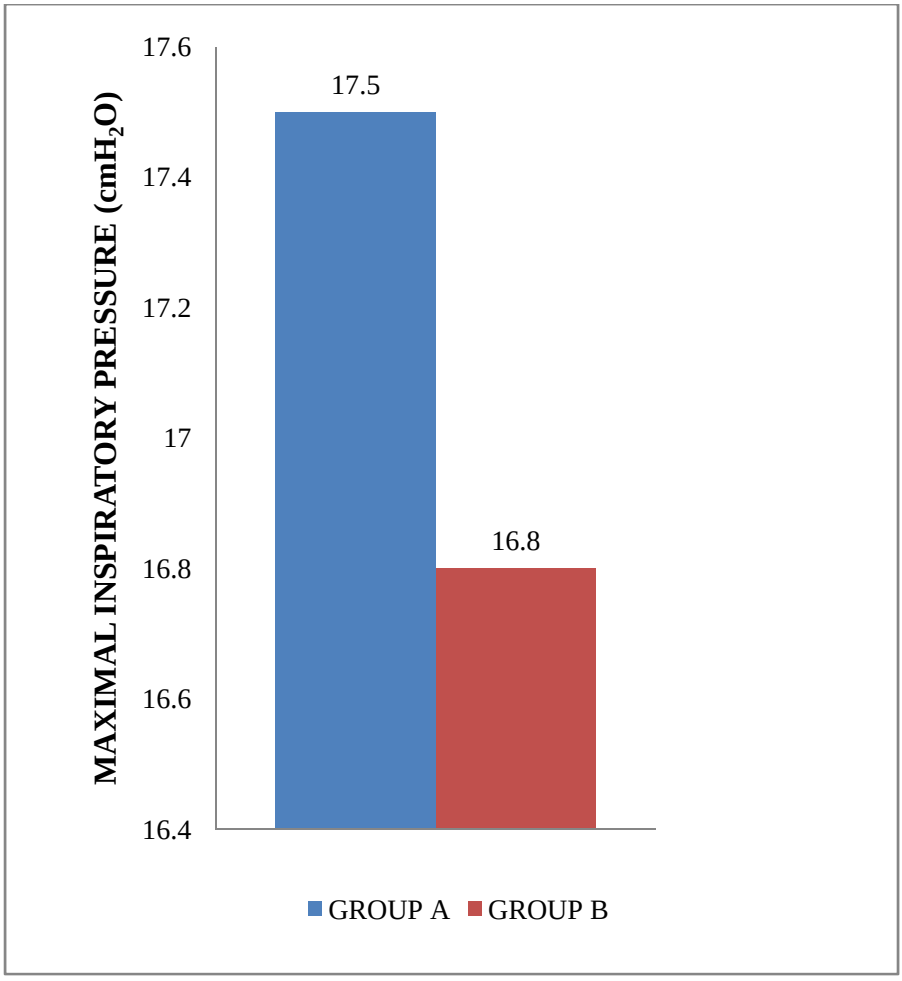
Graph 1: graphical representation of mean of pre and post – test values for maximal inspiratory pressure among group A



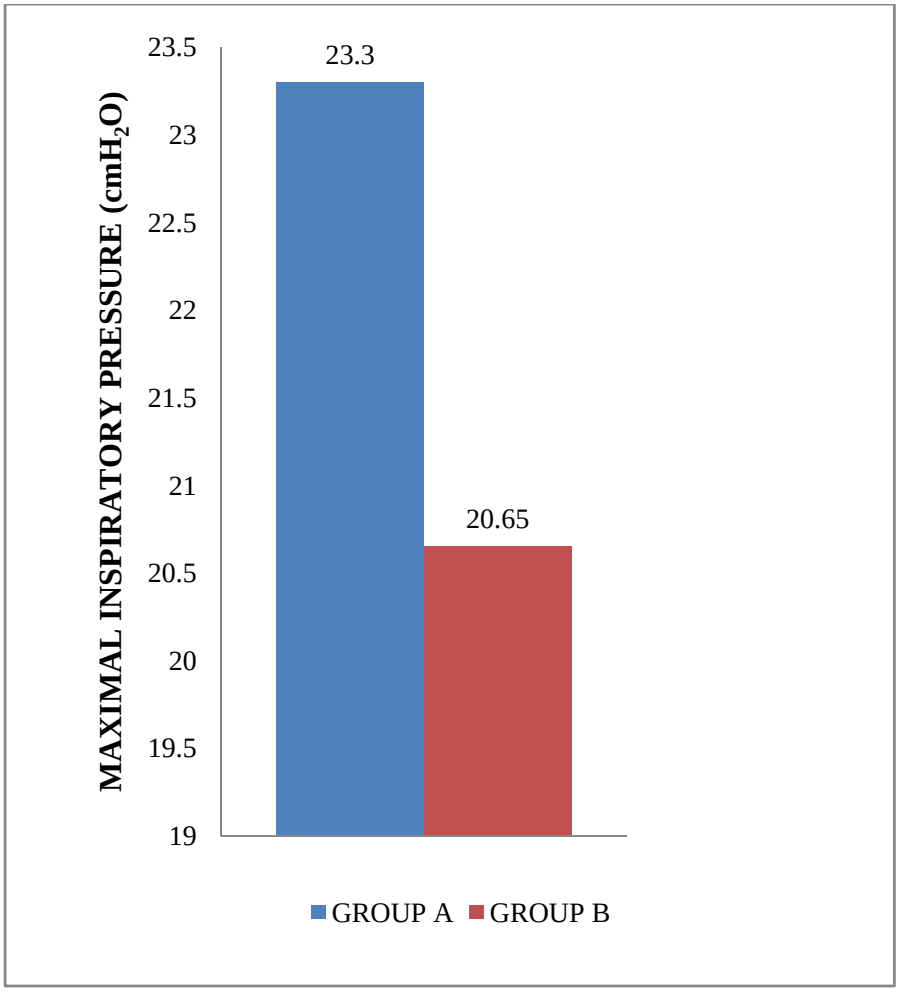
Graph 2 : Graphical representation of mean of pre and post – test values for maximal inspiratory pressure among group B



Graph 3 : Graphical representation of mean of pre – test values for maximal inspiratory pressure between group A and group B.

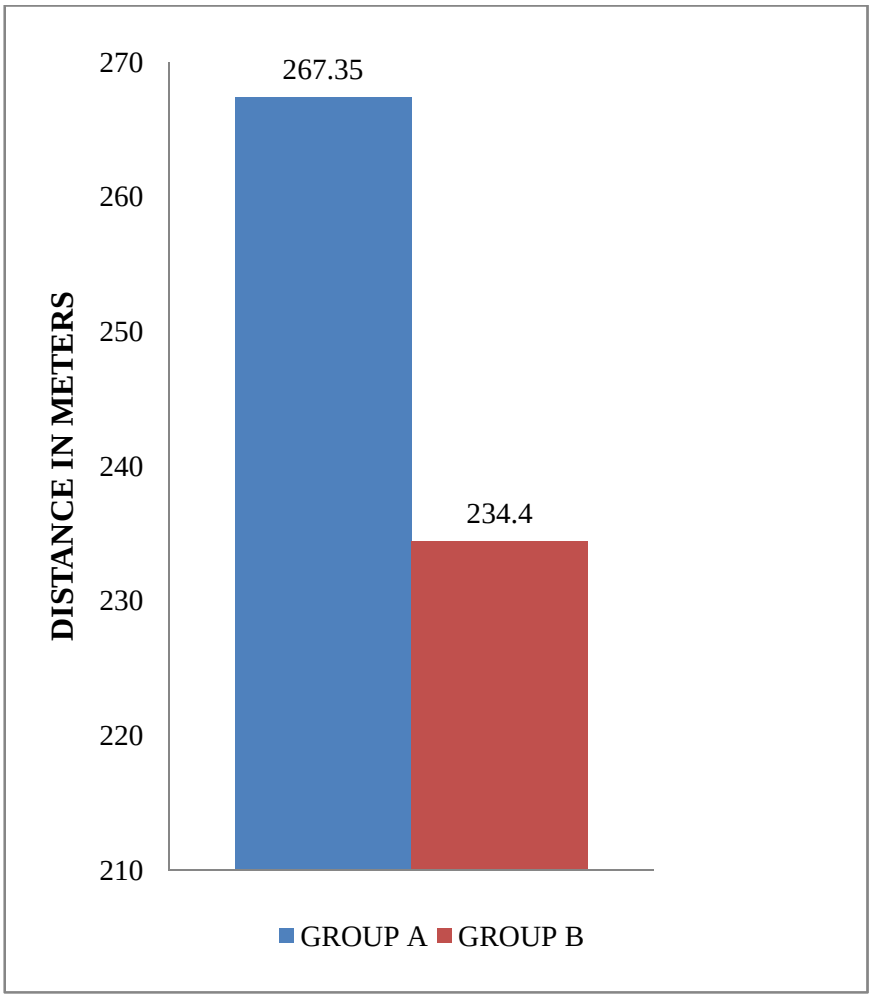


Graph 4 : Graphical representation of mean of post – test values for maximal inspiratory pressure between group A and group B



↳ SIX MINUTE WALK TEST

Graph 5: Graphical representation of mean of post – test values for six minute walk test among group A and group B



6. DATA ANALYSIS AND RESULTS

The changes within the groups were analyzed using paired‘t’ test and the differences among the groups were analyzed using independent‘t’ test.

MAXIMAL INSPIRATORY PRESSURE

- **Pre test values**

When the pre test values of group A & B are analyzed by independent‘t’ test the value is 0.72. The table value at 5% level of significance for 38 degree of freedom is 1.645, which is greater than the calculated value.

- **Group A**

When the pre test and post test values were analyzed by paired‘t’ test, the calculated value is 14.24. For 19 degrees of freedom at 5% level of significance, the table‘t’ value is 1.729. The table‘t’ value is less than the calculated value and hence the null hypothesis is rejected.

- **Group B**

When the pre test and post test values were analyzed by paired‘t’ test, the calculated value is 12.78. For 19 degrees of freedom at 5% level of

significance, the table‘t’ value is 1.729. The table‘t’ value is less than the calculated value and hence the null hypothesis is rejected.

- **Post test values**

The table value for 38 degrees of freedom at 5% level of significance is 1.645. The values are analyzed by independent‘t’ test , the calculated value is 2.763 which is greater than the table ‘t’ value and the alternate hypothesis is accepted.

SIX MINUTE WALK TEST

The table value for 38 degrees of freedom at 5% level of significance is 1.645. The values are analyzed by independent‘t’ test. The calculated value is 5.699 which is greater than the table‘t’ value and the alternate hypothesis is accepted.

7. DISCUSSION

Coronary artery bypass grafting is a surgical procedure for the treatment of Coronary artery disease.[22]

Patients undergoing Coronary artery bypass surgery often develop pulmonary dysfunction, such as atelectasis, restrictive ventilatory disorder and hypoxemia.[10]

The basic mechanism of post-operative pulmonary complication is lack of lung inflation that occurs because of change in breathing pattern to a shallow, prolonged recumbent position, temporary diaphragmatic dysfunction and retained pulmonary secretions. Various physiotherapy procedures are widely used post operatively for the prevention of post- operative complications including deep breathing exercise, incentive spirometry, forced expiratory technique etc. but few studies done on active methods such as facilitate the recovery of respiratory muscle after CABG.

The respiratory muscle stretch is found to be effective to reduce pain to minimize the weakness of respiratory muscles and movement limitations to improve exercise capacity.[37]

Therefore the study was conducted to find the effects of respiratory muscle stretch in CABG patients.

In this study, 40 post-CABG patients were selected according to inclusion criteria. Patients were divided into 2 groups, group A and group B with 20 post-CABG patients in each group.

Group A received respiratory muscle stretch with conventional physiotherapy and group B received conventional physiotherapy alone.

Nobuko Aida et al (2002) used the technique respiratory muscle stretch to alleviate post coronary artery bypass grafting caused by surgical procedure by relaxing the respiratory muscles, to minimize atrophy of the respiratory muscles and movement limitation and improving the ventilatory and non ventilatory functions of the respiratory muscles.[37]

Parameters used for data collections were 6 minute walk test and maximal inspiratory pressure. The statistical analysis was done by using paired‘t’ test and independent’t’ test.

The measures of 6 minute walk test were taken on 7^{th} day and maximal inspiratory pressure was taken on 3^{rd} post operative day and 7^{th} post operative day.

The paired‘t’ test analysis showed that there was a statistically significant improvement within both groups.

The maximal inspiratory pressure showed drop in the 3rd POD but with gradual recovery until the 7th POD in both the groups.

On statistical analysis by using independent‘t’ test showed that there is a significant difference between the two groups in maximal inspiratory pressure and 6 minute walk test.

Maximal inspiratory pressure and six minute walk test is significantly greater in group A than the group B. This is due to respiratory muscle stretch and also with conventional physiotherapy.

The mechanism of respiratory muscle stretch is as follows. It promotes a serial increase in the number as sarcomere, therefore the increased muscle force in function of stretching might be attributable to be better interaction between the filaments of actin and myosin by virtue of the increase in the functional length of the muscle. It relieved the pain due to shortening and increase the degree of freedom for movement and it further increase the exercise capacity.[29]

Thus, the statistical analysis showed the evidence that the respiratory muscle stretch significantly improve the pulmonary function and functional capacity after CABG.

8. SUMMARY AND CONCLUSION

This study was conducted to analyze the effectiveness of Respiratory muscle stretch in post-CABG patients. In this study, 40 CABG patients were selected and divided into 2 groups. Group A and group B, each consists of 20 patients. Group A received respiratory muscle stretch along with conventional physiotherapy and group B received conventional physiotherapy only. Measurement of 6 minute walk test and maximal inspiratory pressure was taken. Statistical analysis was done using paired‘t’ test at 5% level of significance showed that there is significant improvement in patients within the groups. Independent‘t’ test at the 5% level of significance showed that there is a significant difference in both the groups.

Hence it can be concluded that the respiratory muscle stretch has effect in improving the exercise capacity in CABG patients.

9. LIMITATIONS AND SUGGESTIONS

- This study was a short term study; so long term study should be carried out to make a result more valid.
- This study was done on smaller population, so larger populations' studies are recommended.
- In this study parameters used were 6 minute walk test and maximum inspiratory pressure, the effects on other parameters like PFT, breathing pattern are also recommended.
- Respiratory muscle stretch as a technique used in CABG patients. It should be used also in respiratory conditions and neurological conditions like Myasthenia gravis, COPD.
- Respiratory muscle stretch with global postural re-education method was more efficient than the respiratory muscle stretching alone.

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APPENDIX I- PERFORMA

Name:

Age/sex:

Occupation:

Diagnosis:

Date of surgery:

Type of Incision:

Number of grafts:

Date of assessment:

Sustained maximal inspiratory pressure:

Maximum Inspiratory Pressure [MIP_{max}]:

Date	Pre test (3^{rd} POD)	Post test (7^{th} POD)
Pressure in cm H_2O		

Six minute walk test:

Time	
Distance Covered	

APPENDIX- II

INFORMED CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

I _____ voluntarily consent to participate in the research study, “EFFECT OF RESPIRATORY MUSCLE STRETCH TO IMPROVE EXERCISE CAPACITY IN POST CORONARY ARTERY BYPASS GRAFTING PATIENTS ”.

The researcher has explained to me about the research in brief, the risk of participation and has answered the questions related to the research to my satisfaction.

Signature of the subject:

Signature of the researcher:

Signature of the witness: